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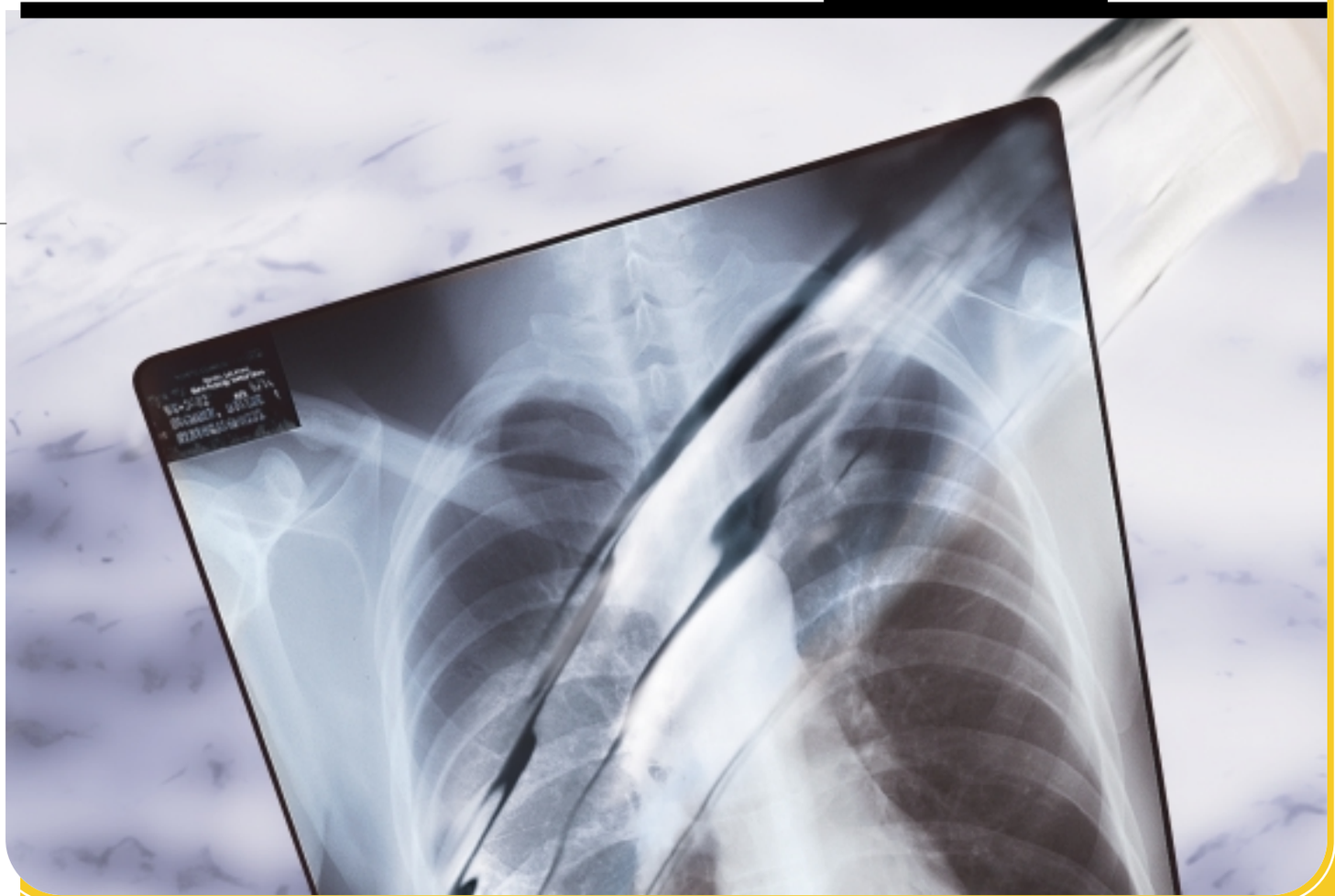
KODAK PROCESSING CHEMICALS

Optimization Guide



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KODAK PROCESSING CHEMICALS OPTIMIZATION GUIDE

This information is intended as a guide to optimizing the performance of KODAK processing chemical products used to process Medical X-Ray films. KODAK processing chemical products are designed to optimize the performance of KODAK films in KODAK equipment including processors and chemical mixers. However, if recommended instructions are followed for KODAK processing chemical products, they can be used in a variety of conditions with other film and equipment products.

If you have any questions concerning information contained in this guide contact your local Kodak representative or contact Kodak's Health Imaging Customer Care Center at 1-800-328-2910.

How to Use This Guide:
The KODAK Chemistry Optimization Guide includes the following sections to provide information and to help optimize image quality:

- pH and Specific Gravity Recommendations for KODAK Medical X-Ray Processing Chemicals
- Chemical Storage
- Proper Mixing Procedures
- Chemical Mixers vs. Pre-Mix
- Recommended Frequency of Mixing
- Use of Starter and Its Function
- Fixer Isn't Just Fixer
- Developer Isn't Just Developer
- How to Successfully Reduce Developer Replenishment Rates
- Flooded Replenishment
- Troubleshooting
  - —Process Control Trends
  - —Why Use a Floating Lid?
  - —Will Fixer Contamination of the Developer Hurt?
  - —How Replenishment Rates Effect Image Quality
  - —Drying Concerns
- Appendix

—Process Control Procedure for General Radiographic Processors

—Process Control Procedure for Mammographic Processors

—Processing Recommendations for KODAK X-OMAT and MIN-R Processors (Service Bulletin No. 30, September 2001)

—Information Needed by Kodak to Facilitate Troubleshooting

—Other Reference Documents

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Product Descriptions

KODAK X-OMAT EX II Developer and Replenisher
KODAK X-OMAT EX II Developer and Replenisher is a high-quality, non-corrosive, *environmentally friendly* general-purpose diagnostic film developer that is specially formulated to provide highest image contrast and bluest image tone when used as part of the recommended KODAK MIN-R 2000 and KODAK MIN-R L film systems. It also offers an enhanced viewbox look with many other KODAK films such as KODAK INSIGHT, X-SIGHT, and T-MAT films by providing improved contrast and image discrimination due to the bluer tone.

KODAK RP X-OMAT Developer and Replenisher
KODAK RP X-OMAT Developer and Replenisher is Kodak's high-quality, most versatile diagnostic film developer. Suitable for standard, rapid, and extended cycle processing, this high-performance developer is specially formulated for superb results with films for:

- General radiography
- Laser imaging
- Application-specific imaging (thoracic)
- Oncology
- Mammography
- Other manufacturers' films

KODAK RP X-OMAT LO Fixer and Replenisher
KODAK RP X-Omat LO Fixer and Replenisher is a versatile fixer recommended for all KODAK diagnostic films and other manufacturers' films. It is suitable for standard, rapid and extended cycles as well as manual processing. Its special formulation reduces emissions of odor-causing acetic acid and sulfur dioxide to significantly improve processing, mixing, and storage environments. An anti-crystallization formula produces a clean-running solution that minimizes buildup on fixer racks and tanks—for reduced maintenance. It is suitable for electrolytic silver recovery with reduced replenishment rates.

Other Products

KODAK Medical X-Ray Liquid Developer and Replenisher
KODAK Medical X-Ray Liquid Developer and Replenisher is a conventional general-purpose developer. It is made by Kodak with the same quality controls used for high-performance processing chemicals.

KODAK Medical X-Ray Liquid Fixer and Replenisher
KODAK Medical X-Ray Liquid Fixer and Replenisher exhibits prompt film drying even when processing conditions are less than optimal. Kodak manufactures this fixer with the same quality standards used for its other processing chemicals. Compatible with a number of silver-recovery methods, KODAK Medical X-Ray Liquid Fixer and Replenisher can be used for:

- General radiography and laser imaging
- Standard and rapid processing cycles
- Other manufacturers' films

Figure 1.1

Film	Developers		
	RP X-OMAT	X-OMAT EX II	Medical X-Ray
KODAK T-MAT/RA Film	★	★	✓
KODAK INSIGHT Film	★	★	✗
KODAK X-SIGHT/RA Film	★	★	✗
KODAK Medical X-Ray Green Film	★	★	★
KODAK Medical X-Ray Blue Film	★	★	★
KODAK X-OMAT K Film	★	★	✓
KODAK X-OMAT UV Film	★	★	✓
KODAK EKTASCAN HN Film	★	★	✓
KODAK EKTASCAN IR Film	★	★	✓
KODAK MIN-R 2000 Film	★	★	✗
KODAK MIN-R L Film	★	★	✗
KODAK RA Duplicating Film	★	★	✓
KODAK EKTASCAN B/RA Film	★	★	✓

★ = Best ✓ = Acceptable ✗ = Not Recommended
Note: not all products are available worldwide.

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Figure 1.2

pH and Specific Gravity of KODAK Health Imaging Medical Processing Chemicals

Product	pH at 77°F (25°C)	Specific Gravity at 77°F (25°C)
KODAK X-OMAT EX II Developer and Replenisher (10 gallons)	10.40 to 10.50	1.070 to 1.080
KODAK RP X-OMAT Developer and Replenisher (10, 20, 200 gallons)	10.22 to 10.38	1.081 to 1.091
KODAK RP X-OMAT Developer and Replenisher, MX-1275 (400 gallons)	10.22 to 10.38	1.071 to 1.081
KODAK Medical X-Ray Liquid Developer and Replenisher, MX-1781 (500 gallons)	10.29 to 10.45	1.051 to 1.061
KODAK Medical X-Ray Liquid Developer and Replenisher (10,265 gallons)	10.29 to 10.45	1.059 to 1.069
KODAK RP X-OMAT LO Fixer and Replenisher	4.25 to 4.45	1.080 to 1.100
KODAK Medical X-Ray Liquid Fixer and Replenisher (10,300 gallons)	4.05 to 4.25	1.068 to 1.088

Chemical Storage

A well-designed concentrate is relatively stable if stored properly. At room temperature (70°F/21°C) concentrate solutions can have a shelf life of up to two years. A robust replenisher solution can stay relatively stable for several weeks if stored under proper conditions. The relative ratio of sulfite (preservative) to hydroquinone (developing agent) is a good indication of the shelf life of the concentrate and replenisher solution. KODAK RP X-OMAT and X-OMAT solutions are specifically designed with optimum preservative levels for longer shelf-life.

Considerations for chemical storage:

- The ideal storage conditions are room temperature in a container with a floating lid to reduce aerial contact.
- Neglecting to use a floating top on the developer solution in a replenishment tank is a frequent cause of oxidation. (See page 5 for further explanation.)
- Storage and use of chemicals at temperatures higher than recommended can accelerate oxidation.
- Typically, developer and fixer replenisher solutions should be mixed only in quantities large enough to be used up within two weeks.

Proper Mixing Procedures

General Mixing Steps

The mixing process is important for obtaining a good and consistent solution. It is important to follow certain guidelines whether the solution is mixed from liquid concentrates or a hybrid of liquid and powder concentrates. KODAK RP X-OMAT and X-OMAT solutions are designed with rigid specifications and will give consistent results if mixed in the proper order and according to directions.

1. Metering water for mixing

- Typically, the water should be added within 3% of the stated amount. This can be accomplished with meters or by weighing the water carefully and accurately calibrating the mixing tanks. Differences greater than 3% could have an adverse effect on the properties of the solution and might be difficult to correct.
- The water temperature should be consistent with the manufacturer's instruction. If circumstances don't allow for this, a trial-and-error process can be used if the rate of dissolution of the concentrates is carefully observed. If the water temperature is colder than the recommendations, a longer stir time may be needed. However, agitation and temperature are critical factors in oxidation. In case of difficulty, the manufacturer should be consulted. For KODAK Health Imaging processing solutions, we recommend using water between temperatures of 70° F to 80° F (21° C to 26.7° C).

2. Mixing concentrate parts

- The agitation should be strong enough to provide adequate mixing but not excessive enough to cause oxidation.
- It is important to follow the recommended mix order. For instance, the Part A or Part I should always be added first. If the mix order is not followed, some components may not dissolve properly or unwanted chemical reactions may occur that could be harmful to the solution.

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- Stirring time should be adequate and components should be completely dissolved before the next part is added. Please review the mixing instructions provided with each product for the recommended stirring times.
- The complete kit or concentrate part should be used to make a complete mix. If components or concentrates are partially used to make a fractional batch, an accurate scale should be used. If a powder part has more than one component or is not uniform, it should not be split beyond the unit package. Powders tend to shift during storage, making an accurate split impossible.
- Water should be used to rinse the bottles.

3. Filtering and packaging solutions

- If possible, solutions should be filtered to remove any particulate matter introduced during the mixing process.
- Containers for mixed solutions should be dedicated to a particular solution to avoid contamination. The containers should be clean.
- Containers should be clearly labeled.
- The solutions should be filled to the top and the containers should be sealed to eliminate exposure to air. This should be done as soon as possible to inhibit aerial oxidation.

Chemical Mixers vs. Pre-Mix

Chemical Mixers

There are two basic types of commercial chemical mixers used in radiographic processing. Both types can be reliable in the preparation of solutions.

- A specific gravity mixer will mix a solution by adding water until a determined specific gravity is reached. A probe is used that is calibrated to the specific gravity. An example of this type of mixer is the KODAK 100-J Chemical Mixer.
- A volumetric mixer such as the KODAK Automixer II Plus employs an electronic probe to determine the necessary volume of the mix.

Important considerations with chemical mixers:

- Concentrates should always be added in the correct order. KODAK RP X-OMAT and X-OMAT and Medical X-Ray concentrates are designated to indicate mix order. The Part A should be added first, then Part B, then the Part C if applicable.
- Proper templates that match the bottles should be used.
- Thorough mixing is necessary after each addition.
- The mixed solution should not be uncovered or have too much contact with air as premature oxidation may occur.
- Ideally, the mixer should have a floating lid to protect the solutions.
- If concentrates are used that have been repackaged by a distributor, the user should be certain the correct quantities of each concentrate are used.
- The concentrates should be examined to be certain there is no premature oxidation due to excessive handling.
- The manufacturer's recommended water-mixing temperature should be observed.

  For KODAK Health Imaging Products processing solutions, we recommend using water between temperatures of 70° F to 80° F (21° C to 26.7° C).
- To verify that the chemistry is acceptable, the pH and specific gravity can be measured. It is important to make these measurements at the recommended temperatures.

There are concerns to be considered when using mixer. The variability of the mixer in terms of accuracy in delivering water or measuring specific gravity will cause variation in solution quality. Also the agitation and exposure to air could cause premature oxidation if it is excessive.

Pre-Mixed Solutions

The use of a solution mixed off-site and delivered to the end user's site is a common practice in the United States and Canada. The developer and fixer solutions are stored in a replenisher barrel or jug. There are some factors to consider in this circumstance to keep solutions stable:

- The solutions should be examined to determine if they are off-color.
- The date of preparation should be available to the user.
- A quantity of solution should be delivered that can be consumed within two weeks.
- The replenisher barrel should be an appropriate size for the volume of delivered chemistry to reduce contact with the air.
- A floating lid should be used in the replenisher barrel.

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When using a pre-mixed solution, there are specific issues that should be considered. The age of the solution when it is delivered and the storage conditions prior to delivery can be factors in causing premature oxidation. Consistent mixing technique and equipment should be used to reduce variability of the solutions.

Recommended Frequency of Mixing or Addition of New Developer

It is not always prudent to add developer or fixer on top of a relatively full replenisher barrel. It is possible for aged solutions to be constantly mixed with a fresh solutions. In some cases a residual amount of oxidized developer or fixer can initiate oxidation reactions in the fresh solutions. KODAK RP X-OMAT and X-OMAT solutions are specifically designed with high preservative levels and, when stored properly, should be relatively resistant to oxidation in most inter-mix conditions. However, the best practice is to use a replenisher barrel that is a proper size for the amount of film processed. Typically, developer and fixer replenisher solutions should be mixed only in quantities large enough to be used up within two weeks. A floating top should be used to cover the solution in a replenishment tank. The solution in the replenisher barrel should be consumed as much as possible before mixing or adding a new batch. This will minimize the amount of oxidized solution carried over from week to week.

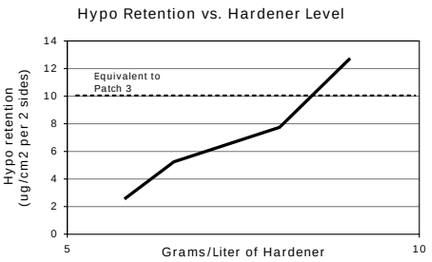
Use of Starter and Its Function

In many cases a starter is added to a developer when fresh solution has been placed in a processing tank. The function of the starter is to minimize changes in fog, speed and contrast during seasoning. The proper amount of starter should be used with all developers and the manufacturer's directions should be followed. Bromide or other halide ions season into the developer during processing. Bromide is a restraining agent in developers. By increasing the halide level prior to seasoning, Starters serve to minimize chemical and sensitometric differences between fresh replenisher solutions and seasoned tank solutions. Kodak tests starter recommendations with all KODAK film products, since different films will have varying seasoning effects in developer solutions.

Fixer Isn't Just Fixer

Hypo retention is a significant concern with many films, particularly films that need to be stored for long term viewing of up to 100 years such as mammography films and dental films. Thiosulfate from the fixer is retained in the emulsion if it isn't adequately removed by washing. The residual thiosulfate will decompose over time and the sulfur will add density or destroy the silver image. Poor washing can result from the use of a fixer with a very low pH. This restricts the film swell and causes inadequate washing. Many fixers have a high level of hardener to allow film to transport in processors with small, weak dryers. This can also lead to poor washing. Unfortunately, the effects on residual hypo may not be noticed for many years. RP X-OMAT LO Fixer was formulated considering the effect on hypo retention, dye stain, and drying when processing KODAK films.

Figure 1.3



Dye stain (Refer to Figure 1.4) (a pink, purplish color on the unexposed clear area of processed film due to retained sensitizing dye) can be caused by a number of processing conditions (cold fixer and/or wash temperatures, under-replenished, dilute or exhausted fixer, electrolytic silver recovery) as well as the brand of fixer itself. Dye stain is also dependent upon the pH of the fixer solution. Depending upon the film type, dye stain can be increased if the pH is too high or too low. RP X-OMAT LO Fixer was formulated at a pH for optimal (minimal) dye stain with KODAK films. There are other factors that also effect fixer pH, such as replenishment and stability. RP X-OMAT LO Fixer is also well buffered to minimize pH fluctuation under these conditions.

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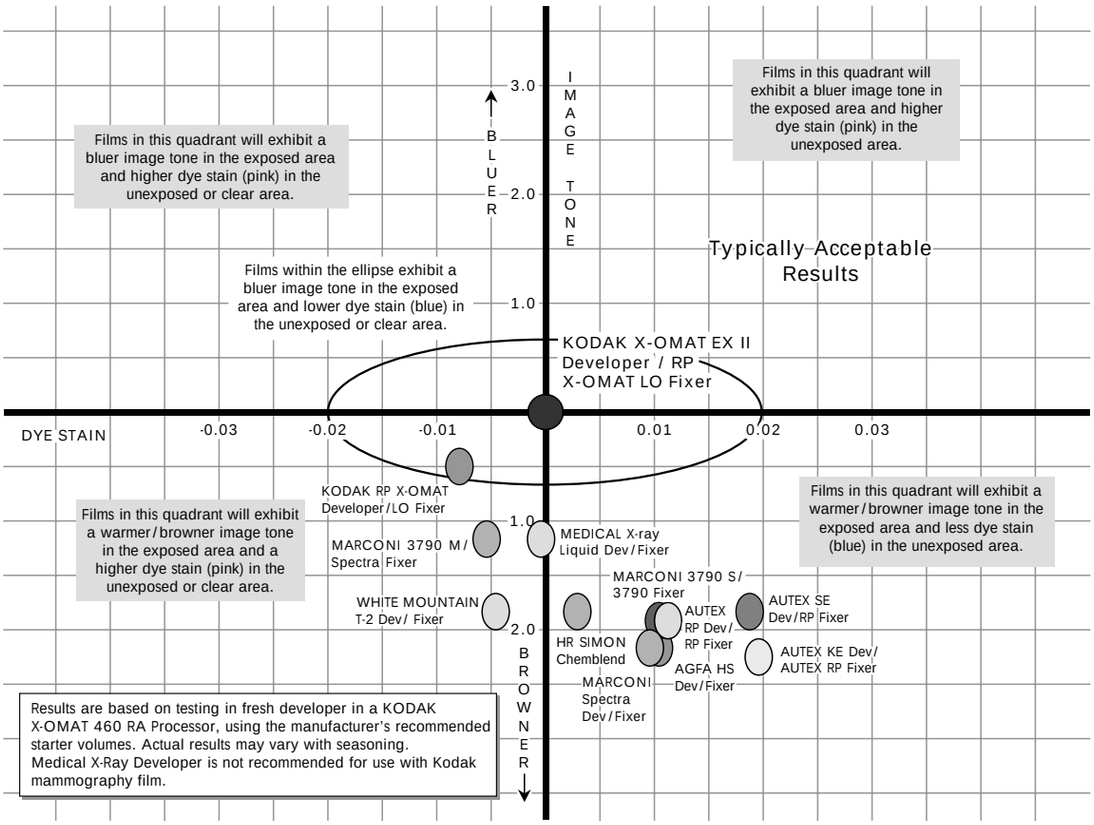
KODAK MIN-R 2000 Film: Dye Stain and Image Tone in Various Processing Solutions

Figure 1.4


Films in this quadrant will exhibit a bluer image tone in the exposed area and higher dye stain (pink) in the unexposed or clear area.
Films in this quadrant will exhibit a bluer image tone in the exposed area and higher dye stain (pink) in the unexposed area.
IMAGE TONE
BLUER
3.0
2.0
1.0
Typically Acceptable Results
Films within the ellipse exhibit a bluer image tone in the exposed area and lower dye stain (blue) in the unexposed or clear area.
KODAK X-OMAT EX II Developer / RP X-OMAT LO Fixer
DYE STAIN
-0.03
-0.02
-0.01
0.01
0.02
0.03
KODAK RP X-OMAT Developer/LO Fixer
Films in this quadrant will exhibit a warmer/browner image tone in the exposed area and a higher dye stain (pink) in the unexposed or clear area.
Films in this quadrant will exhibit a warmer/browner image tone in the exposed area and less dye stain (blue) in the unexposed area.
MARCONI 3790 M/ Spectra Fixer
MEDICAL X-ray Liquid Dev/Fixer
MARCONI 3790 S/ 3790 Fixer
WHITE MOUNTAIN T-2 Dev/ Fixer
AUTEX RP Dev/ RP Fixer
AUTEX SE Dev/RP Fixer
HR SIMON Chemblend
AUTEX KE Dev/ AUTEX RP Fixer
AGFA HS Dev/Fixer
MARCONI Spectra Dev/Fixer
BROWNER
Results are based on testing in fresh developer in a KODAK X-OMAT 460 RA Processor, using the manufacturer's recommended starter volumes. Actual results may vary with seasoning. Medical X-Ray Developer is not recommended for use with Kodak mammography film.

Developers and fixers within the ellipse meet Kodak's minimum requirements for dye stain and image tone with KODAK MIN-R 2000 Film. The ellipse is defined by +/–0.7 b star units for Image Tone and 0.02 units in Dye Stain. These levels of change in image tone and dye stain have been observed to be "noticeable differences" by typical viewers.

The United States Food and Drug Administration (FDA) Mammography Quality Standards Act (MQSA) Final Regulations, effective April 28, 1999, states that processing solutions be capable of developing films in a manner equivalent to the minimum requirements specified by the film manufacturer. Compliance guidance from the FDA recommends that facilities have documentation from the film or chemical manufacturer to support this.

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Image tone (Refer to Figures 1.4, 1.5a, 1.5b) is a measure of both the blue Estar base and the silver image in a radiograph. The image will be very blue at low densities and less blue (brown) at high densities, creating an overall perception of image tone. For some films this can be affected by components in the fixer. KODAK fixers are formulated to give a "colder" (more blue) image tone with KODAK films.

The charts below describe how KODAK T-MAT G/RA and KODAK X-SIGHT L/RA Films perform in various chemistries.

Figure 1.5a

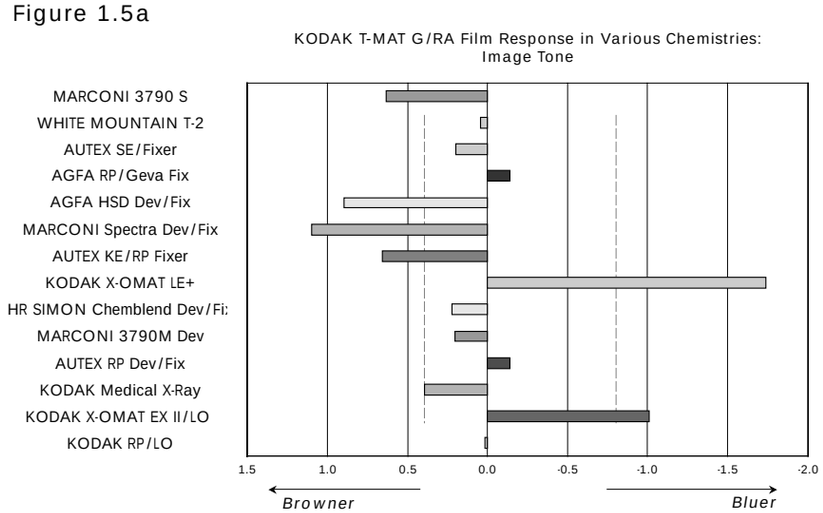
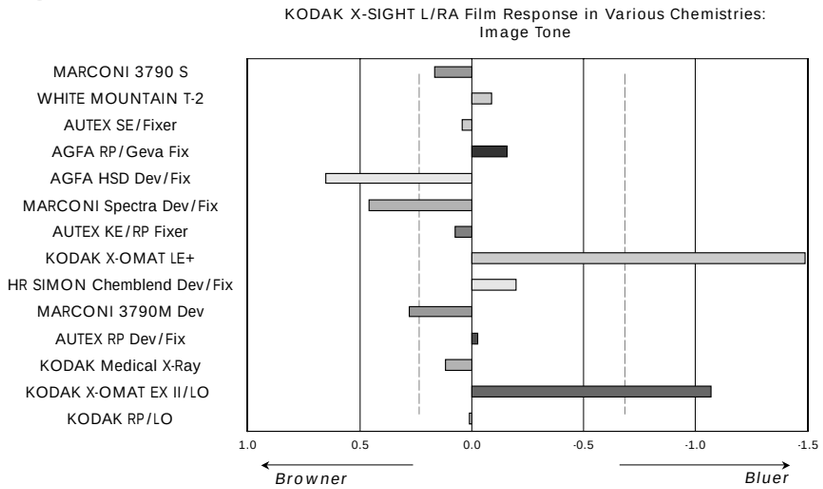


Figure 1.5b



When compared to other manufacturers' developers and fixers, T-MAT and X-SIGHT films are noticeably bluer in tone with KODAK X-OMAT EX II and LE+ chemistries.

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Developer Isn't Just Developer

The choice of developer affects the clinical image of both mammography and general-purpose radiographic films.

Using different chemistries could result in changes in contrast (average gradient), D-Max, the color (image tone and dye stain) and dose (speed) of clinical images. While some developers may increase average gradient, other sensitometric characteristics such as D-Max and speed can be adversely affected.

The United States Food and Drug Administration Mammography Quality Standards Act (MQSA) Final Regulations, effective April 28, 1999, states that processing solutions be capable of developing films in a manner equivalent to the minimum requirements specified by the film manufacturer. Compliance guidance from the FDA recommends that facilities have documentation from the film or chemical manufacturer to support this.

Typically acceptable results are within the ellipse shown in Figure 1.6a and Figure 1.6b. This ellipse is defined by:

- a maximum range of ±10% in optical density at the speed step
- ±0.15 for average gradient of the films processed through KODAK Developer.

Figure 1.6a and Figure 1.6b describe how KODAK MIN-R 2000 Film performs in various chemistries.

Figure 1.6a

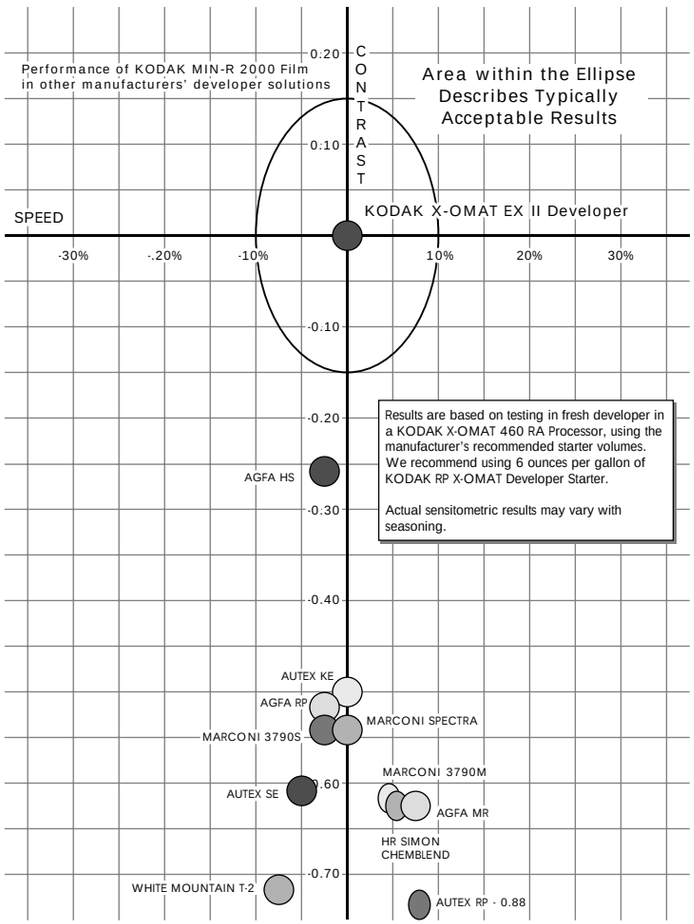
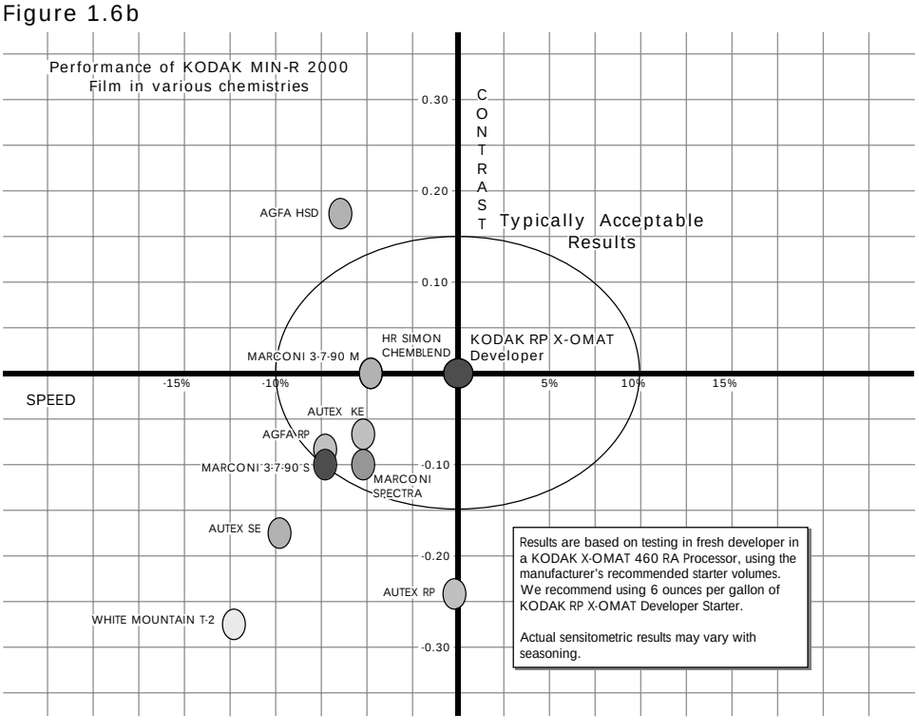


Figure 1.6b



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The developer is also of primary importance for the image quality of general radiography film. The following charts illustrate how different developers affect exposure for KODAK X-SIGHT L/RA and KODAK T-MAT G/RA Films. The use of some developers could potentially result in increased patient exposure. The charts are reflective of the large range of developers currently in use in some regions of the world and the potential large range in patient radiation dose. The range in speed is 50%.

Figure 1.7a

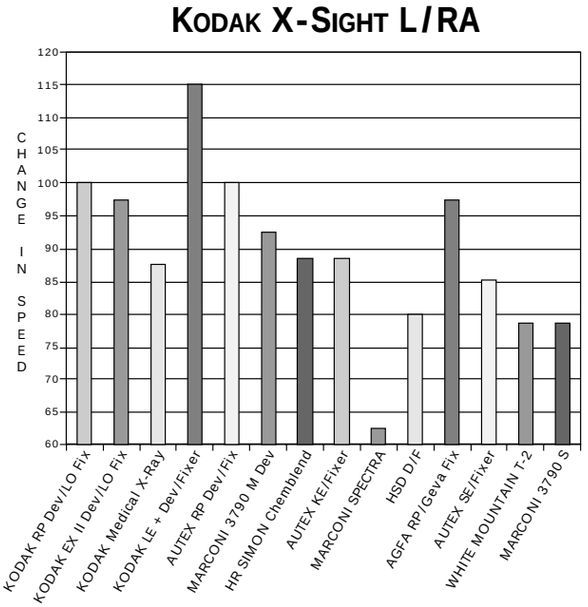
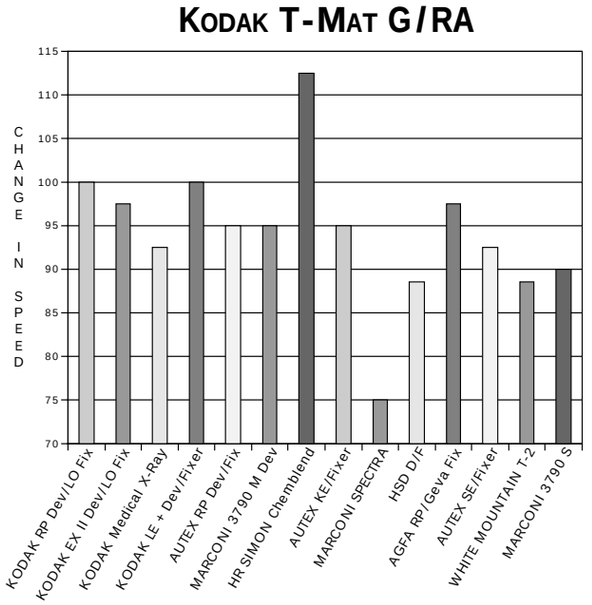


Figure 1.7b



How to Successfully Reduce Developer Replenishment Rates

Costly, complex equipment is available in the marketplace allowing one to reduce the developer replenishment rate. With high-quality developers such as KODAK RP X-OMAT, KODAK X-OMAT EX II, KODAK X-OMAT LE + and KODAK X-OMAT RA/30, the following procedure will allow the reduction of the developer replenishment rate by up to 40% without purchasing additional equipment.

To reduce your developer replenishment rate, you will be required to:

a. use KODAK X-OMAT Developers and Replenishers (RP X-OMAT, X-OMAT EX II, X-OMAT LE + or X-OMAT RA/30)

b. run KODAK T-MAT, X-SIGHT/RA and/or INSIGHT Films

c. process the equivalent of greater than 50 35 x 43 cm films daily

d. perform daily process control monitoring on your processor with a T-MAT or X-SIGHT/RA film

Step 1: Ensure that your processor is set up as per Service Bulletin No. 30 (revised September 2001) for

- developer and fixer replenishment rates
- developer starter volume
- processor time/temperature
- ventilation

If the developer replenishment rate is set at a higher than recommended rate, adjust the rate to the appropriate level and monitor your processor QC daily for two weeks before continuing on.

Step 2: If your processor is set up appropriately, decrease the developer replenishment rate by 10 ml/35 x 43 cm sheet of film. Continue monitoring the process control daily. If minimal changes are noted on QC charts and clinically after 7 to 14 days, continue to the next step.

Step 3: Decrease the developer replenishment by another 10 ml/ 35 x 43 cm sheet of film. Proceed as in Step 2. This procedure may be continued indefinitely or until an unacceptable change is noticed.

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Flooded Replenishment

There may be some conditions where replenishment actually needs to be increased. In typical operating conditions, developer and fixer is replenished only when a film is processed. This is helpful because as the components are depleted when processing a film, they are replaced. However, some components can be consumed even when no films are processed. Developer and fixer components can be oxidized, even when great care is taken to minimize exposure to air (such as filled tanks and floating lids). Also, evaporation can occur under these same conditions. In low-use conditions, it is often necessary to replenish just to compensate for factors such as oxidation and evaporation. Processors that allow "flooded replenishment" help correct this type of degradation of developer and fixer.

Troubleshooting

(Refer to Figure 1.8)

Trends in QC Charts

When Mid Density (MD), Density Difference (DD), and Base + Fog (B + F) differ greatly from expected values and/or indicate an out-of-control processing environment (e.g., reaching or exceeding ±0.15 of the operating levels for MD and DD), always generate another sensitometric strip, making sure that:

- The emulsion side of the film was toward the light source of the sensitometer.
- The temperature of the developer solution in the processor has stabilized before exposing and processing the sensitometric strip.
- The settings on the sensitometer were properly set (i.e., single-sided exposure for single emulsion films, double-sided for double-sided films, appropriate spectral sensitivity (green or blue), recommended DIP switches if the sensitometer is exposure adjustable, etc.).
- The film used was taken from the box set aside for processor quality control.
- The delay between exposing and processing the film is as normally occurs from day to day. (Note that immediate processing after exposure of the sensitometric strip by the sensitometer is recommended.)
- The same densitometer was used to measure MD, DD, and B + F values.
- The calibration of the densitometer is correct.
- If an automatic scanning densitometer is used, the correct channel was used and the programming has not been changed.

Compare MD, DD, and B + F results from the processing control chart to the information below to determine possible causes and corrective actions.

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Figure 1.8

Trends in Graph	Possible Causes	Film Type: MIN-R Family	Film Type: T-MAT Family	Corrective Actions
MD: ↓ DD: ↓ B+F:→	Severe under-replenishment	Yes	Yes	• Check for kinked or air-locked developer replenishment line • Check for improperly mixed (over diluted) developer replenisher • Check amount of water added • Check developer replenishment rate • Check that rate is set as recommended in Service Bulletin No. 30 • Check chemical usage • Check for change in film volume since rate was set and adjust accordingly (raise) • Communicate changes in film volume to processor service firm
MD: ↓ DD: ↓ B+F: ↑ or →	Severe Contamination of developer with fixer	Little increase in fog,	Initial little increase in fog,	• Call service to clean the processor • Drain developer tank • Thoroughly flush tank and developer rack with water • Change the developer filter • Use splash guards • Remove and insert the fixer rack carefully • Process films with edges in contact with film feed tray guides to avoid film jam
MD: ↓ DD: ↓ B+F: →	Severe oxidation of developer	Yes	Yes	• Always use a floating lid on top of the developer replenisher inside the holding tank • Check the developer replenishment rate • Call service to check the processor
	Exhausted developer	Yes	Yes	• Check developer replenishment rate • Check that rate set as recommended in Service Bulletin No. 30 • Check chemical usage • Check for change in film volume since rate was set and adjust accordingly • Communicate changes in film volume to processor service firm • Check processor ventilation
MD: ↓ DD: ↓ B+F: ↑	Expired film	Slight DD ↓ B+F ↑ slight	B+F ↑	• Check film expiration date • Manage film inventory using first-in, first-out method
	Film stored above the recommended temperature and relative humidity	MD ↓ -	MD ↓ slight B+F ↑	• Store unprocessed/unexposed film and processed radiographs between 50 to 70°F (10 to 21°C) and 30 to 50% relative humidity

MD: ↑
DD: ↑
B+F: →
	Slight Contamination of developer with fixer			• Call service to clean the processor
				  • Drain developer tank
				  • Thoroughly flush tank and developer rack with water
				  • Change the developer filter
				• Use splash guards
				• Remove and insert the fixer rack carefully
				• Process film with edges in contact with film feed tray guides to avoid film jams

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Figure 1.8 (continued)

Trends in Graph	Possible Causes	Film Type: MIN-R Family	Film Type: T-MAT Family	Corrective Actions
MD: ↑ DD: ↓ B+F: ↑ or →	Developer temperature higher than recommended (within 5°F [3°C])			• Measure developer temperature using accurate or calibrated thermometer • Verify developer temperature set as recommended in Service Bulletin No. 30 for model of processor • Lower thermostat to correct temperature • Check thermostat to correct temperature • Check water flow and temperature
	Water temperature higher than recommended (if developer temperature set above set point)			• Check temperature of incoming water • Verify water temperature set as recommended in Service Bulletin No. 30 for model of processor • Install mixing valve to regulate water temperature
	Developer time longer than recommended	B+F ↑ slight		• Check immersion time using time-in-solution test tool
	Over-replenishment	B+F →	B+F ↑ (slight)	• Check Service Bulletin No. 30 for recommended rates and adjust accordingly
	No starter added to fresh developer in processor developer tank	B+F →	B+F ↑	• Check Service Bulletin No. 30 for the amount recommended for chemistry, film and processor in use • Add the correct amount of KODAK RP X-OMAT Developer Starter
	Insufficient amount of starter added	B+F →	B+F ↑	• Add the correct amount of KODAK RP X-OMAT Developer Starter
MD: ↓ DD: → or ↑ B+F: →	Developer temperature lower than recommended (within 5°F [3°C])		DD ↑	• Measure the developer temperature using accurate or calibrated thermometer • Verify developer temperature set as recommended in Service Bulletin No. 30 for model of processor • Raise thermostat to correct temperature • Check thermostat and recirculation pump for malfunction • Check water and temperature
	Water temperature lower than recommended (if developer temperature below set point)		DD ↑	• Check temperature of incoming water • Verify water temperature set as recommended in Service Bulletin No. 30 for model of processor • Install mixing valve to regulate water temperature
	Developing time shorter than recommended			• Check immersion time using time-in-solution test tool • Check Service Bulletin No. 30 for the amount recommended for the model
MD: → DD: ↑ B+F: →	Too much starter added (>50 percent)			of processor in use. • Add the correct amount of KODAK RP X-OMAT Developer Starter

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What Happens if I Don't Use a Floating Lid and My Developer Darkens?

The developing agents in a developer solution readily react with oxygen. This process is called oxidation. Loss of developing agents from oxidation or from reaction with silver (exhaustion) will reduce the activity of the developer. The developer must be protected from oxidation. Increased replenishment can partially compensate for oxidation and exhaustion however the use of a floating lid and proper chemical storage conditions is the best method of preventing oxidation and avoids the added cost and environmental impact of increased replenishment.

An antioxidant or preservative will slow the oxidation of the alkaline developer solution. This helps maintain the development rate. The ratio of preservative and developing agent is critical for effective protection from oxidation. In radiographic developer solutions, sulfite salts are commonly used as preservatives. In KODAK RP X-OMAT and X-OMAT developer solutions the levels of preservative and buffer are carefully balanced with the developing agent to ensure long shelf life and consistent seasoning effects over the life of the solutions. (Refer to Figure 1.9)

In a processing tank with elevated processing temperatures, the developer oxidation can be accelerated. The rate of oxidation can be increased by the agitation caused by moving rollers. Evaporation may also occur under these conditions. This can result in precipitation of the developer components. Sometimes precipitation can lead to a build up on the tank walls or rollers and cause scratches on films or even impedes the rotation of rollers. The developer in the processing tank will also carry over into the fixing tank. If these situations are observed it may be necessary to increase replenishment rates to compensate for these adverse effects by adding fresh developer. KODAK RP X-OMAT and X-OMAT solutions are designed to be more efficient and robust and should not require excessive replenishment rates to give consistent processing results. (Refer to Figure 1.10)

Figure 1.9

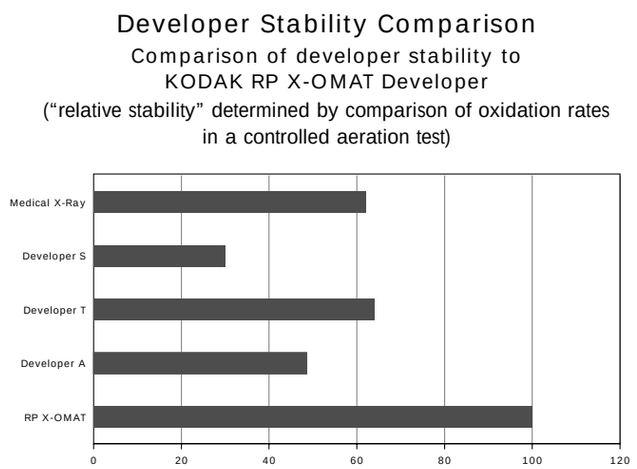
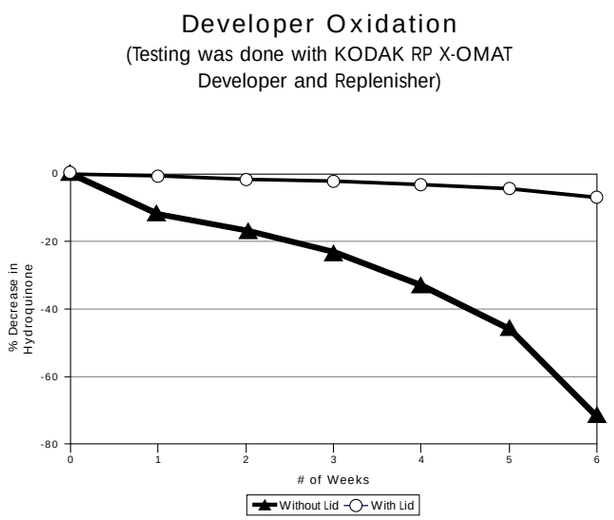


Figure 1.10



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How Does Oxidation of the Developer Affect the Quality of My Clinical Images?

Oxidation of the developer may also affect the image quality by decreasing speed, contrast, D-Max (area of highest optical density) and making the tone of the film appear "warmer" or less blue. (Refer to Figures 1.11–1.14)

Figure 1.11

Response of Typical Film to Developer Oxidation: Average Gradient

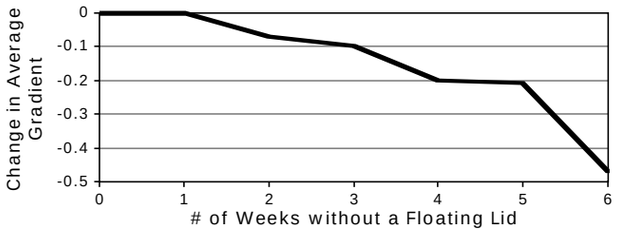


Figure 1.12

Response of Typical Film to Developer Oxidation: Speed

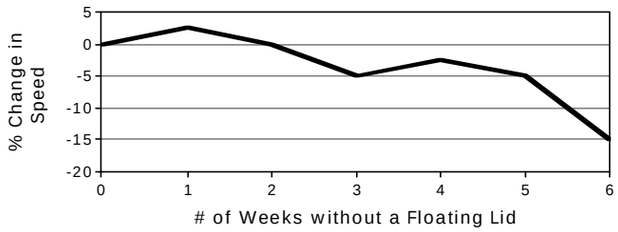


Figure 1.13

Response of Typical Film to Developer Oxidation

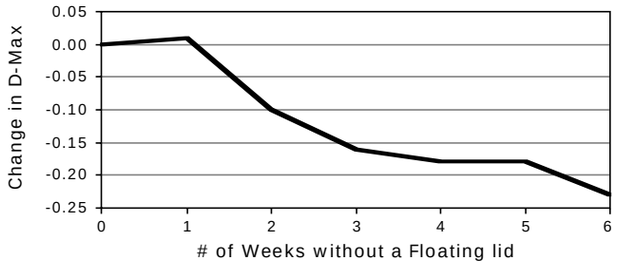
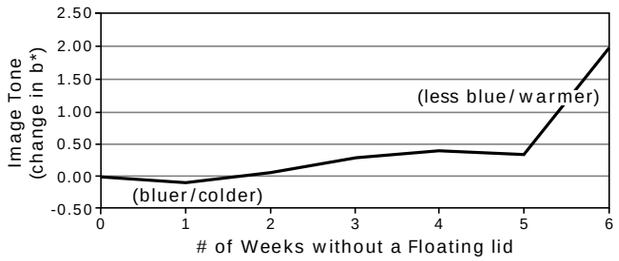


Figure 1.14

Response of Typical Film to Developer Oxidation: Image Tone



Colder image tones are often preferred by radiologists as they reduce eye fatigue and improve diagnostic confidence. A Just Noticeable Difference is felt to be a difference of 0.7. (Refer to Figure 1.14)

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Can Fixer Become Oxidized?

Similar oxidation issues exist for fixer solutions. In fixer solutions, excessive loss of sulfite preservative will cause premature sulfurization of the fixing agents, especially at higher temperatures. Sulfurization can lead to a yellow precipitate and a generation of objectionable odor. KODAK RP X-OMAT LO Fixer solution is designed with high buffer capacity and adequate levels of preservative for KODAK films are processors. KODAK RP X-OMAT LO Fixer solution is designed to be more efficient, so lower replenishment rates can be achieved and consistent processing results can still be obtained.

Some Fixer Dripped in My Developer. Will it Hurt My Process Control and/or Clinical Images?

Varying results may occur depending on the film and fixer type and the level of contamination. Some blue-sensitive films, such as KODAK X-OMAT K Film, will react at very low levels of contamination (less than 0.5 ml/L of hypo) by exhibiting an increase in fog and speed. Some mammography films initially react by exhibiting an increase in contrast and D-Max with low level contamination. It is a common misconception that fixer contamination is indicated by an increase in fog in all films. (Refer to Figures 1.15–1.18)

Figure 1.15

Effect of Fixer Contamination on Contrast

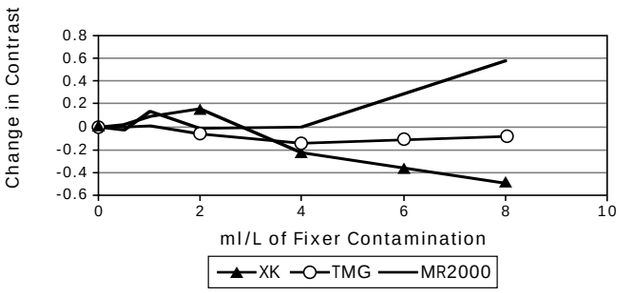


Figure 1.16

Effect of Fixer Contamination on Fog

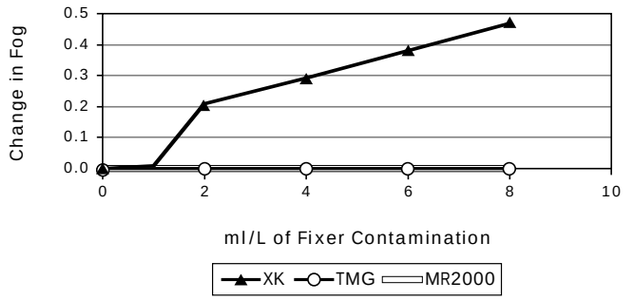


Figure 1.17

Effect of Fixer Contamination on Speed

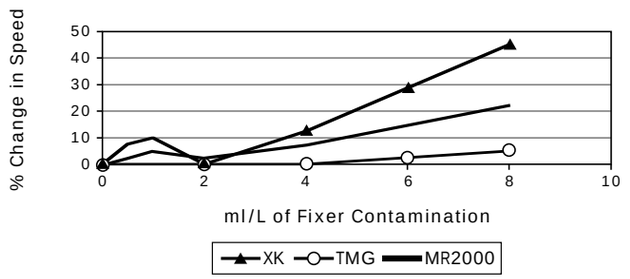
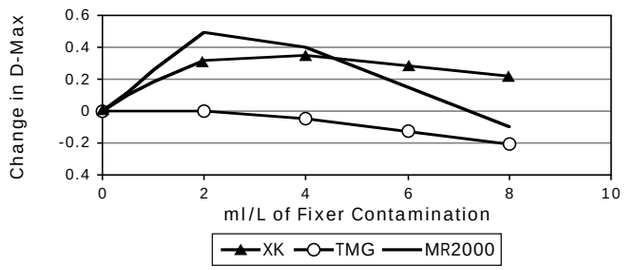


Figure 1.18

Effect of Fixer Contamination on D-Max



Do Different Replenishment Rates Affect Image Quality?

Yes. Excessive over-replenishment with T-Grain films will increase the gross fog and speed and decrease contrast. With some mammography films, over replenishment will result in an increase in speed and D-max and a decrease in contrast. Under-replenishment with quality developers such as KODAK RP X-OMAT and KODAK X-OMAT Developers will not affect the image quality as much with T-GRAIN emulsion films as with mammography films. (Refer to Figure 1.19)

Figure 1.19

Effects of Over- and Under-Replenishment on KODAK T-MAT G/RA Film

Parameter	Over-replenished	Normal Seasoning	Under-replenished
Fog	↑↑	=	=
Speed	↑↑	=	↓
Contrast	↑↑	=	"="
D-Max	"="	=	"="

Processed in a KODAK X-OMAT 460 RA Processor in KODAK RP X-OMAT Developer and RP X-OMAT LO Fixer

Effects of Over- and Under-Replenishment on KODAK X-SIGHT G/RA Film

Parameter	Over-replenished	Normal Seasoning	Under-replenished
Fog	↑↑↑↑	=	=
Speed	↑↑↑	=	↓
Contrast	↓↓↓	=	=
D-Max	"="	=	=

Processed in a KODAK X-OMAT 460 RA Processor in KODAK RP X-OMAT Developer and RP X-OMAT LO Fixer

Effects of Over- and Under-Replenishment on KODAK MIN-R 2000 Film

Parameter	Over-replenished	Normal Seasoning	Under-replenished
Fog	=	=	=
Speed	↑↑↑	=	↓↓
Contrast	↓↓↓	=	"="
D-Max	↑↑	=	↓

Processed in a KODAK X-OMAT 460 RA Processor in KODAK RP X-OMAT Developer and RP X-OMAT LO Fixer

Why Are My Films Tacky?

Drying

The last step in processing an x-ray film is drying. Drying prepares the film for handling, viewing, and storage. The physical characteristics of KODAK films should allow for good drying. Drying requirements will vary depending on the processing cycle, the room temperature, ventilation and relative humidity, film type and throughput. The dryer temperature should be adjusted to meet individual site conditions.

A blower in the processor supplies heated air to the dryer section. Most of the warm air is recirculated; the rest is vented to prevent buildup of excessive humidity in the dryer. Proper processor ventilation is important to achieve proper film drying and decrease surface-pattern, or drying, artifacts. Refer to: Service Bulletin No. 101 (October 1992), Dryer Venting Requirements for All KODAK X-OMAT Processors, publication No. N-923, FaxBack document No. 800220. (This document is available for download on the Kodak Web site at http://www.kodak.com/go/health.)

The dryer temperature should always be set as low as possible while still being consistent with good drying. Use of a lower setting will also result in energy savings for processor operation.

The dryer temperature should never exceed the film manufacturer's recommendations. A common tendency is to raise dryer temperature higher than recommended, especially in response to films not thoroughly dried, or still tacky, exiting the processor. Over-dried films usually exhibit severe drying artifacts that are visible on transmitted light as well as on reflected light.

For these circumstances, check the quality of the chemicals, both developer and fixer, and that replenishment rates and processor ventilation are appropriate. (Chemical quality and adequate replenishment rates are important not only for image

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quality but also for proper drying and film transport.) Drying artifacts visible with transmitted light and other drying problems can usually be eliminated or significantly improved when these areas are corrected. Note that drying or surface patterns that are visible only on reflected light are not artifacts; they are considered normal and acceptable. When the film surface is closely examined in reflected light (the emulsion side of single-emulsion films), slight drying patterns close to the film edges may be visible when the film has been properly dried using the lowest setting as recommended.

To troubleshoot drying problems, review the following causes and implement the solutions, as necessary.

Causes:

- Depleted, oxidized, or poor-quality processing chemicals.
- Poor squeegee action at the wash rack exit or entrance to squeegee.
- Clogged, missing, or out-of-position dryer air tubes; non-uniform or excessive airflow in dryer.
- Inadequate processor venting.
- Excessively high dryer temperature.
- Very cold wash water.

Solutions:

- Replace processing chemicals with fresh solutions.
  - —Check replenishment rates and adjust according to the film manufacturer's recommendations.
  - —Use processing chemicals recommended by the film manufacturer.
- Adjust or replace the wash rack exit squeegee.
- Replace/clean air tube(s).
- Check processor ventilation.
- Reduce dryer temperature to minimum required to produce dry films.
- Provide wash water within the recommended temperature range.
- All actions suggested under "Solutions" should be done by the most appropriate person, that is, one who has received the proper training to perform the necessary task.

Appendix

Process Control Procedure for General Radiographic Processors

ITEMS NEEDED

1. Sensitometer/Densitometer
2. Thermometer (not mercury)
3. Fresh box of control film
4. Monitoring charts

SETTING UP

1. Reserve a fresh box of film most commonly processed in each processor. For example, the film used for mammography should also be used as the control film.
2. To establish your control values, proceed as follows:
3. Expose and process a sheet of control film for five (5) consecutive days for each processor.
4. These results are then averaged to become your "Speed Index" or "Mid Density" "Contrast Index" or "Density Difference" and "Gross Fog Index" or B+F values for each processor.

EXPOSING AND PROCESSING THE CONTROL FILM

1. Set the sensitometer for the appropriate film spectral sensitivity (blue or green). For single emulsion film, be sure that the emulsion side faces the light exposing source. For double emulsion film, it is recommended that an exposure be made on each emulsion side (this is done automatically with a simultaneous double-sided exposing sensitometer).
2. The processor should run at the recommended temperature.
3. Read the density of the middle of each step for both exposures using a densitometer. Record the density next to each step.

DETERMINING THE "DAILY SPEED INDEX" (MD)

1. Determine which step has a density closest to 1.20. Designate that step as the "speed step" for all future speed determinations.
2. Add together the "speed step" densities from each side of the film; divide the result by 2 to obtain the average.
3. Plot this average speed step density reading on the control chart as the "Daily Speed Index."

DETERMINING THE "DAILY CONTRAST INDEX" (DD)

1. Select the step with the density closest to 2.20 but not higher than 2.20. Select the corresponding step on the other exposure (when using two exposures). Add the two density readings and divide by 2 to obtain the average.

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2. Select the step with the density closest to 0.45 but not lower than 0.45. Select the corresponding step on the other exposure (when using two exposures). Add the two density readings and divide by 2 to obtain the average.
3. Subtract the density value obtained in step 2 from the density value obtained in step 1. This value will be the "Daily Contrast Index."
4. Plot the "Daily Contrast Index" on the appropriate section of the chart.

DETERMINING THE "DAILY GROSS FOG INDEX" (B+F)

1. Select two areas on the processed film which have not been exposed.
2. Add the two density readings and divide by 2 to obtain the average.
3. Plot the average as the "Daily Gross Fog Index" on the appropriate section of the chart.

TO EVALUATE "INDEXES," ESTABLISH TOLERANCES AND PLOT TOLERANCE LEVELS

Speed (MD)

- Subtract the density of the speed step for a specific day from the "Daily Speed Index."
- Density differences of less than 0.15 should be considered to be normal process variations.
- Density differences of greater than 0.15 require immediate analysis.

Contrast (DD)

- Subtract the contrast value for a specific day from the "Daily Contrast Index" and calculate the difference.
- Differences less than 0.15 should be considered to be normal process variations.
- Differences greater than 0.15 require immediate analysis.

Gross Fog (B + F)

- Subtract the gross fog value for a specific day from the "Daily Gross Fog Index."
- Density differences less than 0.03 should be considered to be normal process variations.
- Density differences greater than 0.03 require immediate analysis.

Control Film Crossover

- When a new box of control film is introduced into the operation, control exposures should be made on both the old and new stock for five days. At the end of five days, compute a new index based on the average of those five days.

Evaluation of the Control Chart

- A trend exists if a series of consecutive points progresses steadily upward or downward. Such a trend may be a shift taking place slowly and visibly with respect to time.
- Trends or gross fluctuations should be noted and evaluated. Appropriate action should be taken if necessary.

FINAL COMMENTS

- It is recommended that the department keep a processor maintenance log for each processor to record all service on the unit. This log can be used to correlate processor service with processor performance.
- These results were established in seasoned chemistry.

When using a low-crossover film for processor control, it is recommended that a simultaneous double-sided exposing sensitometer be used.

Process Control Procedure for Mammographic Processors

ITEMS NEEDED

1. Sensitometer with 21 density steps.
2. Densitometer.
3. Thermometer (not mercury) with accuracy of ± 0.50°F (±0.30°C).
4. Fresh box of 18 x 24 cm film, the same as that used for mammography.
5. Control charts such as the KODAK Mammography Processing Control Chart (CAT No. 180 1398, Publication No. M7-173). These may be downloaded from the Kodak Web site at http://www.kodak.com/go/mammo.

ESTABLISHING THE BASELINE

1. Ensure that:
   - the processor is thoroughly clean and functioning properly
   - the processor is filled with properly mixed fresh chemicals
   - the proper amount of developer starter has been added
   - the proper developer temperature and replenishment rates have been set.
2. Set aside a fresh box of 18 x 24 cm film that is used for mammography. Designate it as your "QC" film and record the complete emulsion number on the control chart.
3. Set the sensitometer for the appropriate film spectral sensitivity (green) and for single-emulsion film.

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4. On five (5) consecutive days, expose a sensitometric strip using film from the "QC" box; process immediately. Note that:
   - the processor must be at the right temperature
   - the probe of the thermometer should be placed consistently in the same area on the non-drive side of the processor developer tank
   - single-emulsion film must be inserted into the sensitometer so the emulsion side faces the light-exposing source
   - the sensitometric strip must be consistently fed into the processor so that the less-exposed end is fed first.
5. On the fifth day, use the densitometer to read the 21 density steps on each processed film. NOTE: Take the reading from the middle of each step.
6. Average the values of the 21 steps for the five days.

DETERMINING MID-DENSITY (MD)

1. Determine which step has an average density closest to 1.20. Designate this step as the mid-density (MD) step for all future MD determinations and record the step number on the chart.
2. Write the average MD value on the middle line.

DETERMINING DENSITY DIFFERENCE (DD)

1. Select the step with the average density closest to 2.20.
2. Select the step with the average density closest to, but not less than, 0.45.
3. Subtract the density value determined in step 2 from the density value determined in step 1. This value will be the density difference (DD).
4. Designate the two steps as those to be used for all future DD determinations and record the step numbers on the chart. Write the average DD value on the middle line.

DETERMINING BASE + FOG

1. The five-day average of the least-exposed step (usually the first step) determines the Base + Fog of the film. (Any clear area of the film may also be used to determine Base + Fog.)
2. Write the average Base + Fog value on the middle line.

DEVELOPER TEMPERATURE

On the middle line, write the developer temperature recommended by the film manufacturer for your:

- type of film
- developer (chemicals)
- processor
- length of developer immersion time.

ESTABLISHING OPERATING LIMITS

1. The preferred mammography MD and DD operating limits are ± 0.10. The maximum outermost limits are ± 0.15.
2. Add 0.10 and 0.15 to the values on the middle line for MD and DD; write the preferred and maximum upper limits on the control chart.
3. Subtract 0.10 and 0.15 from the values on the middle line for MD and DD; write the preferred and maximum lower limits on the control chart.
4. Add 0.03 to the value on the middle line for Base + Fog; write the upper limit on the control chart. (There is no lower limit for Base + Fog.)

DAILY PROCESSOR QUALITY CONTROL

1. Expose and process a sensitometric strip each morning that mammography films will be processed.
2. Use the densitometer to read the values for MD, DD and Base + Fog, using the same steps recorded on the control chart.
3. Plot the MD, DD, Base + Fog, and measured temperature values on the control chart.
4. Evaluate the results and make any necessary adjustments before processing any films.

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EVALUATING THE CONTROL CHART

1. Points that are plotted on the control chart for MD and DD that are within the ±0.10 control limits should be considered normal process variations.
2. If any points are plotted on the control chart for MD and DD between ± 0.10 and ± 0.15, expose and process another sensitometric strip for comparison. Mammography films may be processed. The processor should be closely monitored to make certain that the outermost limits are not exceeded.
3. If any plotted points on the control chart for MD and DD reach or exceed ± 0.15, expose and process another sensitometric strip for comparison. If the same results are obtained, no mammography films may be processed until the cause is determined and corrected. Plot the results obtained after the process has been brought back "in control." Note the action(s) taken to achieve this in the "Remarks" section on the control chart.
4. Any points plotted for Base + Fog that are within 0.03 are considered to be normal process variations; any points plotted for Base + Fog that exceed + 0.03 require immediate analysis.
5. The developer temperature should remain as close as possible to the temperature recommended by the film manufacturer; it should not vary by more than ±0.50°F (±0.30°C).
6. A trend exists if a series of consecutive points (three or more) progress steadily upward or downward. Such a trend may be a shift taking place slowly and visibly with respect to time. Monitor the processor closely.
7. Trends or gross fluctuations should be noted and evaluated. If necessary, appropriate action should be taken.
8. The "Remarks" section of the control chart should be used to note reasons for fluctuations such as routine preventive maintenance, fresh chemicals or developer starter added, etc.

FINAL COMMENTS

It is recommended that a processor maintenance log be kept for each processor to record all service on the unit. This log can be used to correlate processor service with processor performance. The calibration of the sensitometer, densitometer and thermometer should be checked periodically according to the recommendations, where available, of the manufacturer. The Kodak Mammography Processing Control Chart may be used in various ways to monitor processor performance. For example, a new chart may be used for each month or information may be plotted continuously and a new chart started every 31 days.

Processing Recommendations for:

KODAK X-OMAT Processors

KODAK Multiloaders

KODAK MIN-R Mammography Processor

(Service Bulletin No. 30, September 2001)

1. Updates from Previous Version of Service Bulletin 30
2. Recommended Replenishment Rates
   - For General Radiography, Laser Films, and Non-Dedicated Mammography
     —Area Processors with Smart Replenishment
     —Area Processors without Smart replenishment
     —Length Processors
   - For Dedicated Mammography
     —Area Processors with Smart Replenishment
     —Area Processors without Smart Replenishment
     —Length Processors
3. Recommended Replenisher Mixing
4. Recommended Starter Volumes
5. Recommended Processor Maintenance Timing
6. Reduced Replenishment Rate Recommendations
7. Flooded Replenishment Rate Recommendations
8. Recommended Ventilation Requirements
9. Adjusting the Dryer Temperature
10. Recommended Film Types vs. Processing Cycle
11. General Processor Information

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Updates from Previous Version

New Information:
- KODAK X-OMAT EX II Processing Chemicals.
- Reduced Replenishment Rate information.

Revised Information:
- Starter volumes for KODAK MIN-R 2000 film.
- Flooded Replenishment Starter volume for KODAK MIN-R 2000 Film.
- Replenisher mixing.
- Removed references to extended cycle processing.

Purpose:
- To document the processing recommendations for the following KODAK Processors:
  - —X-OMAT Processor Models M35, M35A, M35M, M35A-M, M43, M43A, Clinic 1, M7B, M7B-E, 270 RA, 3000 RA, 180 LP, 180 LPS, M6A-N, M6AW, M6B, M6R, M8, M6RA, 460 RA, 480 RA, 5000 RA, 1000, 1000A, 1000J, 2000, 2000A.
  - —X-OMAT Multiloader 7000, KODAK X-OMAT Multiloader 300/300 Plus.
  - —MIN-R Mammography Processor.
- To document the current processing recommendations for KODAK Medical Films with KODAK Processing Chemicals that are manufactured in the United States.

Notes:
- This data supersedes all previous replenishment information given in publications for KODAK X-OMAT and KODAK MIN-R Products.
- These guidelines should be used as *initial starting points* only, and may be changed as needed to satisfy specific site conditions and sensitometric results.

Recommended Replenishment Rates

<u>General Radiography, Laser Films, and Non-Dedicated Mammography</u>

For Area Processors with Smart Replenishment
- KODAK X-OMAT Processor Models 270 RA, 3000 RA, 180 LP, 180 LPS, M6RA, 460 RA, 480 RA, 5000 RA
- KODAK X-OMAT Multiloader 7000, KODAK X-OMAT 300/300 Plus
  - —Smart Replenishment is enabled by default.
  - —Replenishment takes place after the equivalent area of a 35 x 43 cm (14 x 17 in.) film has been fed; therefore, replenishment rates must be set for a 35 x 43 cm (14 x 17 in.) film feed.
  - —Additional replenishment occurs automatically during low film usage.

Film Size Processed	Use Condition	Average Amount of 35 x 43 cm Equivalent Film per 8 hrs of Processor Operation	Replenishment Rates (ml per 35 x 43 cm)	
			Developer	Fixer
All	Any	Any number *	60	85
* Flooded replenishment should not be needed due to the automatic compensation for use but it is available if needed to maintain sensitometry for very-low-use conditions.				

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For Area Processors without Smart Replenishment

- KODAK X-OMAT Processor Models M43, M43A, M8, Clinic 1
  - —The equivalent area of a 35 x 43 cm (14 x 17 in.) film is 1505 cm sq. (238 sq. in.).
  - —Replenishment takes place after the equivalent area of a 35 x 43 cm (14 x 17 in.) film has been fed; therefore, replenishment rates must be set for a 35 x 43 cm (14 x 17 in.) film feed.
  - —Replenishment rates need to be set for different usage conditions.

Film Size Processed	Use Condition	Average Amount of 35 x 43 cm Equivalent Film per 8 hrs of Processor Operation	Replenishment Rates (ml per 35 x 43 cm) Developer	Fixer
Equivalent to 35 x 43 cm	High	75 sheets or more	60	85
	Medium	25–75 sheets	80	100
	Low	25 sheets or less*	100	120
* If sensitometry does not stay within control limits, flooded replenishment may be needed.				

For Length Processors

- KODAK X-OMAT Processor Models M35, M35A, M35-M, M35A-M, M7B, M7B-E, M6A-N, M6AW, M6R, M6B, 1000, 1000A, 1000J, 2000, 2000A
- KODAK MIN-R Mammography Processor
  - —Replenishment takes place whenever film is in the entrance rollers.
  - —Replenishment rates must be set according to usage and film size(s) fed.
  - —Film should be fed as recommended in the processor Operator Manual/User Guide.
  - —X-OMAT M35M, M35A-M and MIN-R Mammography Processors are *not recommended* for roll film.

Film Size Processed	Use Condition	Average Amount of 35 x 43 cm Equivalent Film per 8 hrs of Processor Operation	Replenishment Rates (ml per 35 x 43 cm) Developer	Fixer
Roll films 35 cm wide (only)	High	105 linear feet or more	50	70
	Medium	35–105 linear feet	65	85
	Low	35 linear feet or less*	80	100
35 x 35 cm film (only)	High	90 sheets or more	50	70
	Medium	30–90 sheets	65	85
	Low	30 sheets or less*	80	100
Average size intermix film	High	115 sheets or more	50	70
	Medium	40–115 sheets	65	85
	Low	40 sheets or less*	80	100
35 x 43 cm film (only)	High	75 sheets or more	60	85
	Medium	25–75 sheets	80	100
	Low	25 sheets or less*	100	120
* If sensitometry does not stay within control limits, flooded replenishment may be needed.				

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Recommended Replenishment Rates

Dedicated Mammography

A processor is considered dedicated if only single-emulsion film (mammography, ultrasound, etc.) is processed. General-purpose (non-dedicated) film should use the replenishment rates listed for general radiography (see previous section). Note: These guidelines should be used as initial starting points only.

For Area Processors with Smart Replenishment

- KODAK X-OMAT Processor Models 270 RA, 3000 RA, M6RA, 460 RA, 480 RA, 5000 RA
- KODAK X-OMAT Multiloader 7000, KODAK X-OMAT Multiloader 300/300 Plus
  - —Smart Replenishment is enabled by default.
  - —The equivalent area of a 35 x 43 cm (14 x 17 in.) film is 1505 cm sq. (238 sq. in.).
  - —Replenishment takes place after the equivalent area of a 35 x 43 cm (14 x 17 in.) film has been fed; therefore, replenishment rates must be set for a 35 x 43 cm (14 x 17 in.) film feed.
  - —Additional replenishment occurs automatically during low film usage. This feature can be overridden by using software version 3.0 or higher. Note: X-OMAT 3000 RA and X-OMAT 5000 RA Processors have the ability to override this feature without installing new software.
  - —Refer to *Conversion and Processing Instructions for MIN-R 2000 Film* (formerly known as Service Bulletin 244) for additional information.

Film Size Processed	Use Condition	Average Amount of 35 x 43 cm Equivalent Film per 8 hrs of Processor Operation	Replenishment Rates (ml per 35 x 43 cm) Developer	Fixer
MIN-R L MIN-R M	Any	Any number*	105	
MIN-R 2000	Smart Replenishment disabled (recommended)	Any number* 90		
MIN-R 2000	Smart Replenishment enabled	260 sheets or more	90	105
		200 sheets	80	
		150 sheets	70	
		100 sheets	65	
		70 sheets	60	
		Less than 60 sheets	Flooded	Flooded

* Flooded replenishment is available if needed to maintain sensitometry for very-low-use conditions.

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For Area Processors without Smart Replenishment

• KODAK X-OMAT M8 Processor

Note:

• This processor replenishes by area but does not automatically compensate for low-use conditions.

• The M8 processor is scheduled for service discontinuance in the near future.

Film Size Processed	Use Condition	Average Amount of 35 x 43 cm Equivalent Film per 8 hrs of Processor Operation	Replenishment Rates (ml per 35 x 43 cm) Developer	Fixer
MIN-R L	Medium–High	60 sheets or more	105	105
	Low	60 sheets or less*	Flooded	Flooded
MIN-R M	High	150 sheets or more	105	105
	Medium	60–150 sheets	105	122
	Low	60 sheets or less*	122	140
MIN-R 2000	Medium–High	60 sheets or more	90	105
	Low	60 sheets or less*	Flooded	Flooded

* If sensitometry does not stay within control limits, flooded replenishment may be needed.

For Length Processors

• KODAK X-OMAT Processor Models M35-M, M35A-M, M7B, M7B-E, M6A-N, M6AW, M6B, M6R

• KODAK MIN-R Mammography Processor

—Replenishment takes place whenever film is in the entrance rollers.

—Replenishment rates must be set according to usage and film size(s) fed.

—MIN-R L and MIN-R 2000 Films are fed *emulsion side down* in M35-M, M35A-M, and MIN-R Mammography Processors.

—For the KODAK Miniloader 2000P and KODAK Multiloader 700 docked to length replenished processors, mammography rates are set using 18 cm film travel.

Film Size Processed	Film Feeding	Use Condition	Average Amount of 35 x 43 cm Equivalent Film per 8 hrs of Processor Operation	Replenishment Rates (ml per 35 x 43 cm) Developer	Fixer
MIN-R	Single	Medium–High	60 sheets or more	30	30
		Low	60 sheets or less*	Flooded	Flooded
	Double	Medium–High	60 sheets or more	60	60
		Low	60 sheets or less *	Flooded	Flooded
MIN-R M	Single	High	150 sheets or more	30	30
		Medium	60–150 sheets	30	35
		Low	60 sheets or less*	35	40
	Double	High	150 sheets or more	60	60
		Medium	60–150 sheets	60	70
		Low	60 sheets or less*	70	80
MIN-R 2000	Single	Medium–High	60 sheets or more	25	30
		Low	60 sheets or less*	Flooded	Flooded
	Double	Medium–High	60 sheets or more	50	60
		Low	60 sheets or less*	Flooded	Flooded

* If sensitometry does not stay within control limits, flooded replenishment may be needed.

** Use a single 18 x 24 cm film to set the replenishment rates listed.

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Recommended Replenisher Mixing

For best results, mix processing solutions between 70°F and 80°F (21.1°C and 26.7°C).
If using Replenisher Tank:
• Mix only in quantities large enough to be used in 2 weeks.
• A floating lid must be installed in the developer/replenisher tank to reduce oxidation of the developer solution.

If using an Automixer without a floating lid:
• Mix only in quantities large enough to be used in 1 week.

For information on specific processors, refer to the "General Processor Information" at the end of this document.

Recommended Starter Volumes

Film	Environment	Developer	Starter (Added to Developer Tank)
MIN-R 2000	Dedicated MIN-R 2000	RP X-OMAT X-OMAT EX II	6 fl oz. per gallon (178 ml)
	Non-Dedicated MIN-R 2000	RP X-OMAT X-OMAT EX II	3 fl oz. per gallon (89 ml)
All Other	N/A	All (except RA/30)	3 fl oz. per gallon (89 ml)
		X-OMAT RA/30	No Starter Added

Recommended Processor Maintenance Timing

• Drain, clean, and refill the developer and fixer processing tanks monthly or as experience indicates.
• Specific site conditions may dictate more or less cleaning.
• Follow the maintenance instructions and safety procedures specified in the processor's Operator Manual/User Guide and Service Manual.
• Be sure to follow all environmental regulations when disposing of processing solutions.

Reduced Replenishment Rate Recommendations

It may be possible to reduce the developer replenishment rate by up to 40% by using KODAK X-OMAT EX II Developer and Replenisher, KODAK RP X-OMAT Developer and Replenisher, or KODAK X-OMAT RA/30 Developer and Replenisher with KODAK T-MAT Film, KODAK X-SIGHT Film, or KODAK INSIGHT Film.

For more information, refer to the Chemistry Matters Optimization Guide (Pub. M6-408, CAT No. 149 1109) and/or contact Health Imaging, Eastman Kodak Company, at 1-800-328-2910.

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Flooded Replenishment Rate Recommendations

- For low-use rates, if sensitometry does not stay within control limits, flooded replenishment may be needed to maintain the developer solution at a continuously fresh chemical activity. This is accomplished by replenishing not only when film is fed or area accumulated, but also on the basis of additional replenishment added during the processor on-time with an automatic replenishment timing system.
- When in the flooded mode, developer starter is added to the replenishment tanks at a rate of 89 ml per gallon or 25 ml per liter (3 fl oz per gallon) for all films *except MIN-R 2000, or when X-OMAT RA/30 Chemicals are used*.
- For MIN-R 2000 Film, developer starter is added to the replenishment tank at the rate of 118 ml per gallon or 33 ml per liter (4 fl oz per gallon).
- No starter is used for KODAK X-OMAT RA/30 Developer.
- For detailed information on how to set up each processor for flooded replenishment, see the appropriate service publication for that processor.
- The processor setup should be done by qualified service personnel.
- When filling the developer replenishment or processor tank, add starter according to the table below.

KODAK Developer	Flooded Mode	Add Starter?	
		Replenishment Tank	Processor Tank
X-OMAT EX II	No	No	Yes
	Yes	Yes	No*
RP X-OMAT	No	No	Yes
	Yes	Yes	No*
Medical X-ray	No	No	Yes
	Yes	Yes	No*
X-OMAT RA/30	No	No	No
	Yes	No	No

* Fill the processor tank with chemistry that was mixed in the replenishment tank.

For All KODAK Processors
(except KODAK X-OMAT 1000, 1000A, 1000J, M43, M43A, Clinic 1, M8)

- Initially set the developer and fixer replenishment rates at 65 ml per 35 x 43 cm film. This amount will be fed into the processor every 5 minutes.
- Once set, the rate may be changed depending on the individual circumstances.
- Monitoring the processor sensitometry is required in order to change replenishment rates.
- Use the following recommendations as replenishment rates are reduced:
  1. Monitor sensitometry (speed and contrast).
  2. Reduce developer and fixer replenishment rates by 5 ml.
  3. Monitor sensitometry for 2 weeks.
  4. If no change is seen, rates may be reduced by another 5 ml.
  5. Once a change is seen, increase the developer and fixer rates by 5 to 10 ml.

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For KODAK X-OMAT 1000, 1000A and 1000J Processors

- Initially set the regular developer and fixer replenishment rates at 100 ml per 35 x 43 cm film.
- Set the flooded replenishment rate at one-half of the above amount. The processor will feed the one-half amount (in this case, 50 ml) into the processor every 20 minutes.
- Monitoring the processor sensitometry is required in order to reduce replenishment rates.
- Use the following recommendations as replenishment rates are reduced:
  1. Monitor sensitometry (speed and contrast).
  2. Reduce developer and fixer replenishment rates by 5 ml.
  3. Monitor sensitometry for 2 weeks.
  4. If no change is seen, rates may be reduced by another 5 ml.
  5. Once a change is seen, increase the developer and fixer rates by 5 to 10 ml.

For KODAK X-OMAT M43, M43A, Clinic 1 Processors

- Set the flooded replenishment rate at 100 ml for developer and 120 ml for fixer.
- The processor will deliver these volumes every 24 minutes to maintain sensitometry.
- *Do not reduce these rates.*
- Monitoring the processor sensitometry is required.

For KODAK RP X-OMAT Processor, Model M8

- Set the flooded replenishment rate at 105 ml for 35 x 43 cm.
- The processor will deliver these volumes every 8 minutes to maintain sensitometry.
- Monitoring the processor sensitometry is required.

Recommended Ventilation Requirements

- The processing area should have 10 air changes per hour, 24 hours per day, 7 days per week. For example, a 10 x 10 x 10-foot room has a volume of 1000 cubic feet, so the ventilation system should supply the room with 10,000 cubic feet of fresh air per hour, 24 hours per day, 7 days per week.
- For through-the-wall installations, the air pressure in the darkroom area where the processor is located must be of higher pressure than the surrounding rooms to assure that the airflow through the processor is in the correct direction.
- For processor exhaust ventilation requirements, refer to Service Bulletin 101 and the appropriate service publication for the processor.

Adjusting the Dryer Temperature

- Use the lowest possible dryer temperature that will maintain proper film drying.
- Drying requirements vary depending on the processing cycle, the room temperature, ventilation and relative humidity, film type, and throughput. Adjust dryer temperature to meet individual site conditions.
- Different processing cycles require different dryer temperatures to compensate for the varying times the film is in the dryer section.
- Refer to the processor Operator Manual/User Guide for instructions.

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Recommended Film Types vs. Processing Cycle

The following chart summarizes which films can be processed in which processor and at which processing cycle.
K = K/RA (Kwik) Cycle, using X-OMAT RA/30 Chemicals
S = Standard Cycle, using RP X-OMAT, X-OMAT EX II, Medical X-Ray Chemicals
R = Rapid Cycle, using RP X-OMAT, X-OMAT EX II, Medical X-Ray Chemicals
NA = Not Applicable
NR = Not Recommended
Note: Medical X-Ray Developer is *not recommended* for use with MIN-R Films.

KODAK Film	KODAK Processor							
	M6R M7B M7B-E M8 M6A-N M6AW M6B	M35-M, M35A-M	M35 M35A M43 M43A Clinic 1	270 RA 3000 RA ML 300 ML 300 Plus M6RA 460 RA 480 RA 5000 RA XML 7000	180 LP 180 LPS	1000 1000A 1000J	2000 2000A	MIN-R Mammo Processor
Available Cycles ->	S	S	S	S R K	R	S	S R	S R
T-MAT RA Films	S	S	S	S R K	NA	S	S R	S R
INSIGHT Films	S	S	S	S	NA	S	S	S
X-SIGHT RA Films	S	S	S	S R K	NA	S	S R	S R
MIN-R 2000	S	S	NR	S	NA	NR	NR	S
MIN-R M	S	S	NR	S	NA	NR	NR	S
MIN-R L	S	S	NR	S	NA	NR	NR	S
RA Duplicating	S	S	S	S R K	NA	S	S R	S R
EKTASCAN B/RA	S	S	S	S R K	NA	NR	S	S R
EHN/EHNC	S	S	S	S R	R	NR	S	NR
EIR/EIRC	S	S	S	S R	NA	NR	S	NR
All Other Films	S	S	S	S	NA	S	S	NR

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General Processor Information

NA = Not Applicable (starter not needed for K/RA cycle)
NC = Not Controlled (temperature)
NR = Process Not Recommended for this film type
Note: Starter Volume for MIN-R 2000 Film assumes a dedicated environment. If non-dedicated, use "All Other Film" info.

Processor Model	Cycle	Approx Devl Tank Volume	Starter Volume		Temperature			Transport Speed	Capacity 35 x 43 cm (18 x 24 cm)	Approx Devl Time	Approx Drop Time** 35 x 43 cm (18 x 24 cm)
			All Other Film fl oz (ml)	MIN-R 2000 Film fl oz (ml)	Devl °F (°C)	Fixer* °F (°C)	Water °F (°C)				
		gal (L)						in./min (cm/min)	films/hr	seconds	seconds
M35 M35A	S	2.25 (8.3)	6.5 (190)	N/R	92° F (33.3° C)	NC	40° – 85° F (4° – 29.4° C)	94 30 (76.2)	33	150	
M35-M M35A-M				13 (380)					94 (145)	33	150 (135)
2000 2000A	S	2.25 (8.3)	6.5 (190)	13 (380)	92° F (33.3° C)	NC	40° – 85° F (4° – 29.4° C)	30 (76.2)	94	33	150
	R			NR	94° F (34.4° C)			40.1 (101.6)	126	25	112 (101)
MIN-R Mammo	S	2.25 (8.3)	6.5 (190)	13 (380)	92° F (33.3° C)	NC	40° – 85° F (4° – 29.4° C)	30 (76.2)	(145)	33	150 (135)
M43, M43A Clinic 1	S	2.3 (8.7)	6.5 (190)	NR	93° F (33.9° C)	NC	40° – 85° F (4° – 29.4° C)	24 (61.0)	90	27	127
M7B M7B-E	S	2.25 (8.3)	6.5 (190)	13 (380)	94° F (34.4° C)	NC	40° – 85° F (4° – 29.4° C)	42 (106.7)	146 (250)	27	120 (116)
3000 RA	S		6.5 (190)	13 (380)	94° F (34.4° C)	90° F (32° C)		42 (106.7)	148 (250)	26	111 (104)
270 RA ML300	R	2.25 (8.3)	6.5 (190)	NR	99° F (37.2° C)	95° F (35° C)	40° – 85° F (4° – 29.4° C)	57 (144.8)	201	19	82
ML 300+ XML7000	K		NA	NR	96° F (35.6° C)	90° F (32° C)		76 (193.0)	270	4.5	62
M6A-N M6AW M6B M6R	S	2.8 (10.7)	Molded: 8.5 (250) Stainless: 8 (237)	17 (500)	95° F (35° C)	NC	M6A-N: 85° – 90° F (30° – 32.2° C) M6AW, M6B: 40° – 90° F (4° – 32.2°C)	66 (167.6)	229 (393)	25	90 (86)
M8	S	4.3 (16.4)	13 (380)	26 (760)	96° F (35.6° C)	96° F (35.6° C)	40 – 90° F (4° – 32.2° C)	69 (175.3)	264	21	90 (85)
M6RA	S		8.5 (250)	17 (500)	95° F (35° C)			66 (167.6)	233 (393)	24	95 (89)
460 RA 480 RA	R	2.8 (10.7)	8.5 (250)	NR	101° F (38.3° C)	95° F (35° C)	40° – 85° F (4° – 29.4° C)	99 (251.5)	351	16	60
5000 RA	K		NA	NR	98° F (36.6° C)			132 (335.3)	480	11	45
180 LP 180 LPS	R	2.25 (8.3)	6.5 (190)	NR	100° F (37.8° C)	100° F (37.8° C)	40° – 90° F (4° – 32.2° C)	63 (160.0)	180	18	79
1000 1000A 1000J	S	1.0 (3.8)	3.0 (90)	NR	95° F (35° C)	NC	40° – 85° F (4° – 29.4° C)	17 (43.2)	50 (84)	43	173

* Fixer temperature may exceed value listed due to internal ambient temperatures in the processor.
** Drop Time is defined as the time from the Lead Edge In (LEI) to the Trail Edge Out (TEO) for a 35 x 43 cm film. ( ) represents 18 x 24 cm LEI/TEO.

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Information Needed by Kodak to Facilitate Troubleshooting

When contacting Kodak for assistance with image quality concerns, having as much of the following information as possible will facilitate all troubleshooting efforts:

Facility name:

Contact:

Phone:

Film Distributor:

Processor maintenance performed by:

Kodak Account Manager and/or Mammography Sales or Analog Imaging Specialist:

- Current and previous emulsion numbers (i.e., 429 029 03):
  QC: Clinical:
- Date the change or problem was noticed:
- Description of change (what was observed and who noticed it):

- Optical densities of the 21 steps from the sensitometric strip
- Characteristic (H&D) curve.
- Optical densities of the "normal" and "suspect" film halves from the split phantom test with emulsion roll and slit numbers of both emulsions
- Make and model of processor:
- Mix of film manufacturers/types processed with mammography film:
- Volume of films (number of sheets per typical 8-hour day):

- Starter volume:
- Has volume of film changed recently:
  If yes were replenishment rates altered:
- Double or single fed:
- Brand/Type of chemicals:
- Developer:
  Fixer:
- Chemicals: premixed automixed facility mixed
- Floating Lids in place on chemistry tanks: Y N
- Has brand or type of chemistry changed either developer and/or fix?: Y N
  If yes please indicate previous and present developer and fix:

- Developer temperature:
- Fixer temperature:
- Water temperature:
- Replenishment rates (milliliters of developer and fixer, fully defined in terms of number and size of film, and length of film travel, e.g., 25 milliliters of developer and 30 milliliters of fixer per one 18 x 24 cm KODAK MIN-R 2000 Film, single film feeding, 24 cm of film travel):
  - —Developer:
  - —Fixer:
  - —Calibration date:
  - —Replenishment rates as per Service Bulletin 30: Y N
    If no explain:
- Have chemistry samples been sent to Kodak for analysis: Y N
  If yes was corrective action taken:
  If no please explain:
- Dates last and previous preventive maintenance procedure (PM) performed. Last: Previous:
  Was chemistry changed out? Y N
  If no, date it was last changed:
- Description of any unusual circumstances (e.g., films processed only 2 days per week, etc.):

- Has venting been checked: Y N
- Is there an air gap present: Y N
- Is processor QC stable: Y N
  If no describe problem:
- Is Phantom QC stable: Y N
  If no describe:
- Has Optical density of the clinical changed: Y N
- Have technical factors of the clinical image changed (kVp, target, filter, compression) Y N

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Reference List

Environmental

1. KODAK Publication No. J-314. Indoor Air Quality and Ventilation in Photographic Processing Facilities. CAT No. 184 9298. This publication may be downloaded from the Kodak Web site at: http://www.kodak.com/US/en/corp/environment/kes/pubs/pdfs/J314.pdf
2. KODAK Publication No. J-212. The Technology of Silver Recovery for Photographic Processing Facilities. CAT No. 810 2436. http://www.kodak.com/US/en/corp/environment/kes/pubs/pdfs/j212.pdf
3. KODAK Publication No. J-215. Recovering Silver from Photographic Processing Solutions. CAT No. 804 1576. http://www.kodak.com/US/en/corp/environment/kes/pubs/pdfs/J215.pdf
4. KODAK Publication No. J-411. Dealing with Hazardous Waste and Processing Effluents at Photographic Processing Facilities. CAT No. 101 9678. http://www.kodak.com/US/en/corp/environment/kes/pubs/pdfs/J411.pdf
5. Material Safety Data Sheets http://www.kodak.com/US/en/corp/hse/prodSearchMSDS.shtml

Processing

6. KODAK Service Bulletin No. 101. *Drying Venting Requirements for All KODAK X-OMAT Processors* http://www.kodak.com/US/en/health/support/service/101.shtml
7. KODAK Service Bulletin No. 30 (September 2001 revision), *Processing Recommendations for KODAK X-OMAT and MIN-R Processors,* Publication No. N-923, FaxBack No. 800210 (See Appendix)
8. Chemistry Matters, by Alan S. Fitterman, CAT No. 887 3911
9. The Basics of Film Processing in Medical Imaging. Arthur G. Haus, Susan M. Jaskulski, Medical Physics Publishing, 1997.
10. The KODAK MIN-R 2000 System Mammography Optimization Guide, CAT No. 193 9826
11. The KODAK MIN-R L Users Guide, CAT No. 179 6739